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(54) Title: A BUS FOR MEDIUM VOLTAGE ELECTRICAL FACILITIES

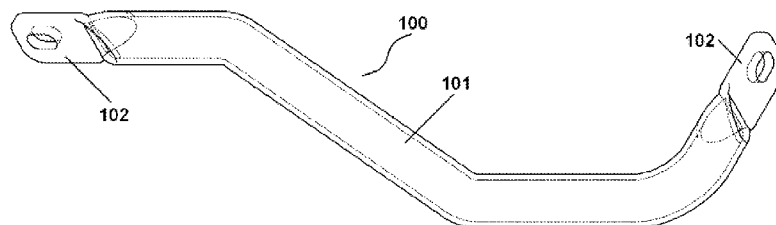


Fig. 1

(57) Abstract: A bus for medium voltage electrical facilities is provided. The bus (100) comprises a body (101) which is in form of a tube and is made of copper. The bus further comprises at least one coupling portion (102) for conductively coupling the bus with a corresponding device inside or outside the medium voltage electrical facility. The bus has reliable performance in terms of current withstand capability, temperature rise, and mechanics characteristics. In this way, the material waste in the prior buses may be avoided, thereby significantly reducing the product costs.

A BUS FOR MEDIUM VOLTAGE ELECTRICAL FACILITIES

FIELD OF THE INVENTION

[0001] The present invention generally relates to a bus, and especially to a bus for use in medium voltage electrical facilities.

5 BACKGROUND OF THE INVENTION

[0002] Copper buses are commonly used in varied of medium or high voltage electrical facilities, such as switch cabinet or switchgear assembly. Traditionally, copper buses in such electrical facilities are usually in form of solid copper bars. As known, in a large-scale electrical facility, there are usually a great number of buses, which would consume a significant quantity of copper materials. Moreover, for those buses which are used to carry high currents, the sectional area for each solid copper bus is usually greater, thereby deteriorating the problem of material costs.

[0003] In the meantime, it has been found that there is a tendency of a current, for example, an alternating electric current (AC), to distribute itself within a conductor with the current density being largest near the surface of the conductor, decreasing at greater depths. This phenomenon is known as skin effect. As a result, lots of copper materials inside the bus leave unused in operation, especially when the load current is not too high. That is, there is a significant material waste in the known buses in form of solid copper bars as used in electrical facilities.

[0004] In view of the foregoing, there is a need in the art for a bus for use in electrical facilities, especially in medium voltage facilities, which is more cost effective while providing acceptable electrical conductivity.

SUMMARY OF THE INVENTION

[0005] Embodiments of the present invention present a novel bus for use in medium voltage electrical facilities.

[0006] In one aspect, embodiments of the present invention provide a bus for use in a medium voltage electrical facility. The bus comprises a body in form of a tube and made of copper.

[0007] In an exemplary embodiment, the body of the bus has a circular cross section. In another exemplary embodiment, the body of the bus may have other cross sections.

[0008] In an exemplary embodiment, the bus further comprises at least one coupling portion for conductively coupling the bus with a corresponding device inside or outside the medium voltage electrical facility. In an exemplary embodiment, the at least coupling portion has a flat shape and the comprises an opening.

[0009] In an exemplary embodiment, the medium voltage electrical facility may be a medium voltage switchgear assembly. Further, the medium voltage switchgear assembly may be a secondary medium voltage switchgear assembly.

[0010] In another aspect, embodiments of the present invention provide a busbar
5 comprising the bus described above.

[0011] In another aspect, embodiments of the present invention provide a use of the above-mentioned bus in a medium voltage electrical facility.

[0012] In an exemplary embodiment, the medium voltage electrical facility is a medium voltage switchgear assembly.

10 [0013] In an exemplary embodiment, the medium voltage switchgear assembly is a secondary medium voltage switchgear assembly.

[0014] In accordance with embodiments of the present invention, the buses used in medium voltage electrical facilities are in form of copper tube rather than the traditional solid copper bars. Experiments have shown that has the proposed bus has reliable performance in terms of current
15 withstand capability, temperature rise, and mechanics characteristics. In this way, the material wastes in the prior art buses may be avoided, thereby significantly reducing the product costs.

[0015] Other features and advantages of embodiments of the present invention will also be understood from the following description of specific exemplary embodiments when read in conjunction with the accompanying drawings, which illustrate, by way of example, the principles of
20 the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] The embodiments of the invention that are presented in the sense of examples and their advantages are explained in greater detail below with reference to the accompanying drawings, in which:

25 [0017] Fig. 1 shows a bus for use in medium voltage electrical facilities in accordance with an exemplary embodiment of the present invention;

[0018] Fig. 2 shows the cross sections of the buses in accordance with an exemplary embodiment of the present invention; and

[0019] Fig. 3 shows the coupling portion of the bus shown in Fig.1 in accordance with an
30 exemplary embodiment of the present invention; and

[0020] Fig. 4 shows a diagram of a medium voltage switchgear assembly in which the buses in accordance with an exemplary embodiment of the present invention are utilized.

[0021] Throughout the figures, same or similar reference numbers indicates same or similar elements.

DETAILED DESCRIPTION OF EMBODIMENTS

[0022] Hereinafter, the principle and spirit of the present invention will be described with reference to the illustrative embodiments. It should be understood, all these embodiments are given merely for the skilled in the art to better understand and further practice the present invention, but not for limiting the scope of the present invention.

[0023] In general, embodiments of the present invention provide a bus for use in medium voltage electrical facilities such as switch cabinet or switchgear assembly. As will be apparent from the further discussions below, the buses used in medium voltage electrical facilities are in form of copper tube rather than the traditional solid copper bars. A tube-shaped copper bus may achieve reliable performance in terms of current withstand capability and temperature rise, but uses much less amount of copper. In this way, the material wastes in the prior art buses may be avoided, thereby significantly reducing the product costs.

[0024] Reference is first made to Fig. 1, where a schematic diagram illustrating the bus for use in medium voltage electrical facilities in accordance with an exemplary embodiment of the present invention is shown.

[0025] As shown, the bus 100 in accordance with embodiments of the present invention comprises a body 101. The body 101 is made of copper materials, and is in form of a tube. That is, unlike the traditional bus body which is shaped as a solid bar, the bus 100 in accordance with the present invention has a body 101 with hollow cavity. As such, the costs caused by copper materials may be reduced.

[0026] In accordance with embodiments of the present invention, the cross section of the body 101 may be of varied of shapes. For example, as shown in Fig. 2, the body (i.e., the copper tube) may have a circular cross section.

[0027] It should note that in accordance with embodiments of the present invention, the diameter and the thickness of the copper tube may be determined depending on the specific requirements and conditions. Furthermore, in practice those skilled in the art could readily contemplate additional or alternative shape for the cross section of the bus body (i.e., the copper tube) depending on specific requirements and conditions. The scope of the present invention is not limited in these regards.

[0028] Referring back to Fig. 1, as shown, the bus 100 in accordance with the present invention may also have at least one coupling portion 102. The at least one coupling portion 102 of the bus is used to conductively couple the bus 100 with a corresponding device or apparatus inside or outside the hosting medium voltage electrical facility.

[0029] Referring to Fig. 3, a detailed view of the coupling portion 102 is illustrated. As shown, the coupling portion 102 is of a flat shape, with a hole 103 included thereon. The flat shape enables a relative large contact area between the coupling portion 102 and the device being coupled.

The hole 13 is primarily used to fix the bus 100 in the medium voltage electrical facility. In accordance with embodiments of the present invention, the coupling portion 102 may be also made of copper. Of course, any other appropriate conductive materials are also possible.

[0030] It should note that the flat shape factor of the coupling portion 102 is just for the purpose of illustration. The coupling portion 102 may have any other suitable shapes. Moreover, though the bus 100 as shown in Fig. 1 and Fig. 3 has two coupling portions 102 at both end of the body 101, it is just exemplary. In fact, the bus 100 may have any number of coupling portions which could formed in any appropriate positions of the bus 100.

[0031] As mentioned above, due to the skin effect, the current trends to distribute itself within a conductor with the current density being largest near the surface of the conductor, decreasing at greater depths. Therefore, theoretically the bus in form of copper tube could reduce the material costs while maintaining acceptable conductivity. Though a series of experiments, it is found that when achieving equivalent capabilities for carrying load current, the buses in form of copper tube in accordance with the present invention may reduce the amount of materials significantly compared with the traditional buses in form of tube bars.

[0032] For example, the reduction of materials by using the buses in accordance with embodiments of the present invention may be seen clearly from the following tables. More specifically, tables 1 and 2 show comparison of the traditional bus (in form of solid copper bar) and the proposed bus (in form of copper tube) with diameter of 25 mm and 20 mm, respectively. It can be seen that the material reductions are remarkable.

Table 1

	Diameter (mm)	Thickness (mm)	Section (mm ²)	Material Reduction rate compared with the copper bar with the diameter of 25 mm (%)	Surface Area (mm ²)	Carry Current (A)
Traditional Bus	20	\	314	64%	62.8	628
	22	\	379.94	77%	69.08	759.88
	25	\	490.625	100%	78.5	981.25
Proposed Bus	25	3	207.24	42%	138.16	580.272
	25	4	263.76	54%	131.88	738.528
	28	3	235.5	48%	157	659.4
	28	4	301.44	61%	150.72	844.032
	30	2.5	215.875	44%	172.7	604.45
	30	3	254.34	52%	169.56	712.152
	30	4	326.56	67%	163.28	914.368
	36	3	310.86	63%	207.24	870.408
	36	5	486.7	99%	194.68	1362.76
	36	6	565.2	115%	188.4	1582.56
	40	2.5	294.375	60%	235.5	824.25
	40	5	549.5	112%	219.8	1538.6
	40	7	725.34	148%	207.24	2030.952

Table 2

	Diameter (mm)	Thickness (mm)	Section (mm ²)	Material Reduction rate compared with the	Surface Area	Carry Current
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				copper bar with the diameter of 20 mm (%)	(mm ²)	(A)
Traditional Bus	20	\	314	100%	62.8	628
	22	\	379.94	121%	69.08	759.88
	25	\	490.625	156%	78.5	981.25
Proposed Bus	30	2.5	215.875	69%	172.7	604.45
	30	3	254.34	81%	169.56	712.152
	30	4	326.56	104%	163.28	914.368
	36	3	310.86	99%	207.24	870.408
	36	5	486.7	155%	194.68	1362.76
	36	6	565.2	180%	188.4	1582.56
	40	2.5	294.38	94%	235.5	824.25
	40	5	549.5	175%	219.8	1538.6
	40	7	725.34	231%	207.24	2030.95

[0033] Further, as can be readily appreciated by those skilled in the art, the temperature rise is an important metric for the buses used in electrical facilities. That is, the temperature variations of the buses during operations should be in a range of tolerance. Experiments have shown that buses in accordance with embodiments of the present invention have acceptable and stable performance in this regard.

[0034] Referring to Fig. 4 where a medium voltage switchgear assembly is illustrated, the buses in form of copper tube are installed at the positions P1-P6. It is found that the temperature rises at the positions P1-P6 during operation are acceptable and stable enough, as shown in the following table. In table 3, ΔT_n refers to the temperature variation (°C) compared to the environment temperature at the measurement instant T_n .

Table 3

	ΔT_1	ΔT_2	ΔT_3	ΔT_4	ΔT_5	ΔT_6
P1	62.1	62.5	63.2	56.2	56.6	56.0
P2	67.0	66.1	66.3	60.0	57.1	57.9
P3	68.5	68.9	70.4	59.5	58.0	57.1
P4	69.3	68.9	71.4	56.8	56.1	55.9
P5	54.5	55.6	55.7	47.1	47.6	45.9
P6	50.3	51.3	51.4	44.6	41.2	46.2

[0035] Additionally, mechanics experiments on the buses in accordance with embodiments of the present invention prove that the copper tube is also feasible in terms of peak withstand current. That is, the mechanics characteristic of a copper tube also enables it to be used as a bus within a medium voltage facility like a switch cabinet.

[0036] In accordance with embodiments of the present invention, there is presented a new kind of bus for use in medium voltage electrical facilities like switch cabinet or switchgear assembly, where the body of the bus is made of copper and in form of tube. By using such buses in the medium voltage electrical facilities, the costs caused by copper material may be significantly reduced. Specifically, in practice the buses in accordance with embodiments of the present invention are suitable for use in secondary medium voltage switch cabinets.

[0037] In accordance with embodiments of the present invention, there is presented a

busbar comprising the bus in the form of copper tube.

[0038] In accordance with embodiments of the present invention, there is presented a use of the copper tube bus in a medium voltage electrical facility. Preferably, the medium voltage electrical facility is a medium voltage switchgear assembly. More preferably, the medium voltage switchgear assembly is a secondary medium voltage switchgear assembly.

[0039] In accordance with embodiments of the present invention, there is presented a use of the copper tube busbar in a medium voltage electrical facility. Preferably, the medium voltage electrical facility is a medium voltage switchgear assembly. More preferably, the medium voltage switchgear assembly is a secondary medium voltage switchgear assembly.

[0040] It is believed that the disclosure set forth herein encompasses multiple distinct inventions with independent utility. While each of these inventions has been disclosed in its preferred form, the specific embodiments thereof as disclosed and illustrated herein are not to be considered in a limiting sense as numerous variations are possible. The subject matter of the disclosure includes all novel and non-obvious combinations and sub-combinations of the various elements, features, functions and/or properties disclosed herein. Similarly, recitation in the disclosure and/or the claims of "a" or "a first" element, or the equivalent thereof, should be understood to include incorporation of one or more such elements, neither requiring nor excluding two or more such elements.

[0041] It is believed that the following claims particularly point out certain combinations and sub-combinations that are directed to one of the disclosed inventions and are novel and non-obvious. Inventions embodied in other combinations and sub-combinations of features, functions, elements and/or properties may be claimed through amendment of the present claims or presentation of new claims in this or a related application. Such amended or new claims, whether they are directed to a different invention or directed to the same invention, whether different, broader, narrower or equal in scope to the original claims, are also regarded as included within the subject matter of the inventions of the present disclosure..

[0042] Therefore, it is to be understood that the embodiments of the invention are not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. Although specific terms are used herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

CLAIMS

1. A bus for use in a medium voltage electrical facility, comprising a body, wherein the body is in form of a tube and is made of copper.

5 2. The bus according to Claim 1, further comprising at least one coupling portion for conductively coupling the bus with a corresponding device inside or outside the medium voltage electrical facility.

3. The bus according to Claim 2, wherein the at least one coupling portion has a flat shape.

4. The bus according to Claim 3, wherein the coupling portion comprises an opening.

10 5. The bus according to any one of Claims 1-4, wherein the medium voltage electrical facility is a medium voltage switchgear assembly.

6. The bus according to Claim 5, wherein the medium voltage switchgear assembly is a secondary medium voltage switchgear assembly.

7. A busbar comprising a bus according to any one of Claims 1-6.

8. Use of a bus according to any one of Claims 1-6 in a medium voltage electrical facility.

15 9. Use of the bus according to Claim 8, wherein the medium voltage electrical facility is a medium voltage switchgear assembly.

10. Use of the bus according to Claim 9, wherein the medium voltage switchgear assembly is a secondary medium voltage switchgear assembly.

DRAWING

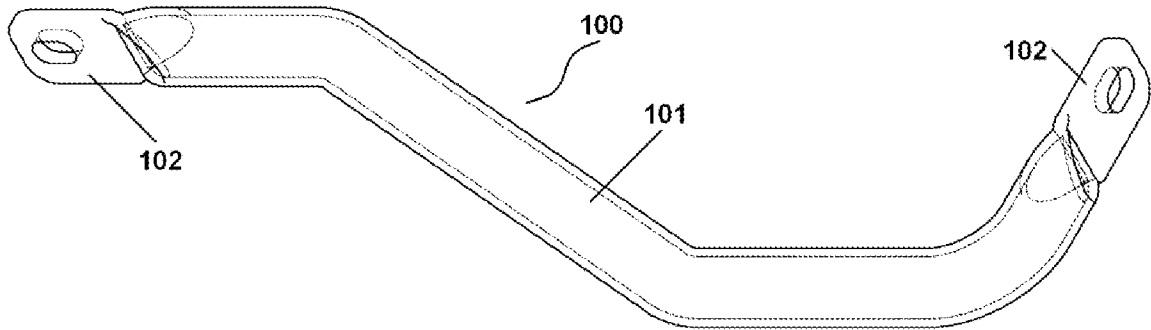


Fig. 1

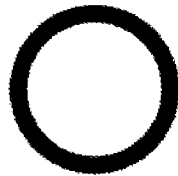


Fig. 2

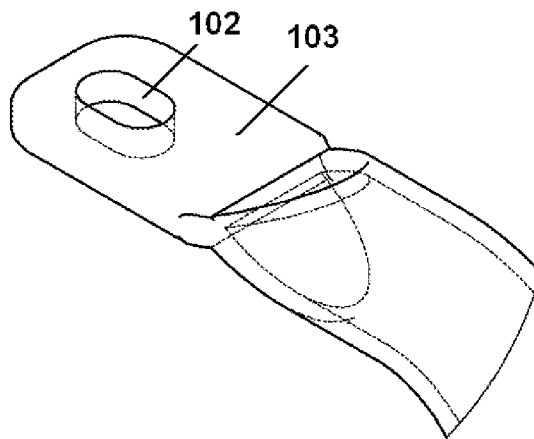


Fig. 3

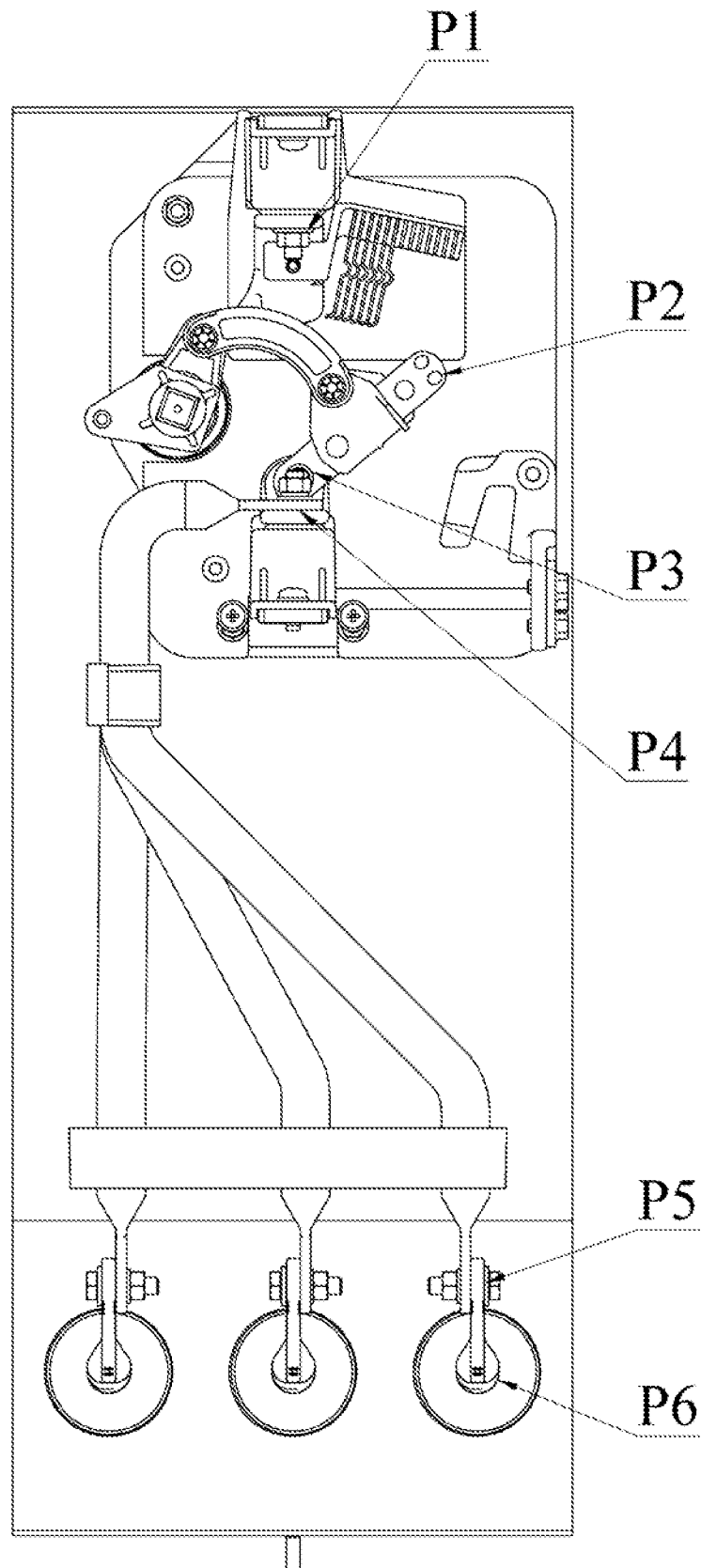


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/074134

A. CLASSIFICATION OF SUBJECT MATTER

H01B 5/06 (2006.01) i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC:H01B, H02G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT,CNKI,WPLEPODOC: bus, busbar, tube, tubular, hollow, medium w voltage, connecting w portion, coupling w portion, copper

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN201226258Y (Liaoning Boji Electronic Technology Co., Ltd.) 22 Apr. 2009(22.04.2009) paragraph 8 in the description, figures 1-2	1-10
X	CN201984857U (Tong Zhihong) 21 Sep. 2011(21.09.2011) paragraphs 0016-0017 in the description, figure 1	1-10
X	US2003/0236016A1 (FURUKAWA ELECTRIC CO LTD) 25 Dec. 2003(25.12.2003) paragraphs 0039-0042, figures 1-5	1-10
X	JP2004-80972A (TOYOTA MOTOR CORP) 11 Mar. 2004(11.03.2004) paragraphs 0013-0014, figures 1-3	1-10

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:	“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
“A” document defining the general state of the art which is not considered to be of particular relevance	“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
“E” earlier application or patent but published on or after the international filing date	“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“L” document which may throw doubts on priority claim (S) or which is cited to establish the publication date of another citation or other special reason (as specified)	“&” document member of the same patent family
“O” document referring to an oral disclosure, use, exhibition or other means	
“P” document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search 9 Jan. 2013(09.01.2013)	Date of mailing of the international search report 31 Jan. 2013 (31.01.2013)
Name and mailing address of the ISA/CN The State Intellectual Property Office, the P.R.China 6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China 100088 Facsimile No. 86-10-62019451	Authorized officer YANG Guanghui Telephone No. (86-10)62411742

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2012/074134

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN101458974A (Luo Zhizhao) 17 Jun. 2009(17.06.2009) the whole document	1-10

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Form PCT/ISA /210 (patent family annex) (July 2009)